Prediction of Equatorial Spread F Based on Assimilation of Daytime GPS Data

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LONG-TERM GOALS

Under ONR grant N00014-03-1-0243, we will explore the value of airglow imagers in the testing of assimilative models of the equatorial ionosphere. We have made data exchange agreements with both the Jet Propulsion Laboratory and the Air Force Research Laboratory in this regard. Our first goal is to verify conditions calculated by the models prior to the breakout of Equatorial Spread F (ESF), a severe ionospheric weather phenomenon. The second goal is to see if data assimilation can be used to predict these conditions and subsequently predict ESF itself. A third goal is to calibrate GPS occultation data using the Arecibo radar and then apply this method to determine the off-equatorial E-region conductivity.

OBJECTIVES

The objectives of the project are:

(1) to compare COSMIC occultation measurements with Arecibo data;

(2) to use the data assimilation techniques to predict the airglow characteristics and, eventually, ESF;

(3) to use GPS occultations to determine the off-equatorial *E*-region conductivity.

APPROACH

We will work closely with the data assimilation modeling group at the Air Force Research Laboratory (AFRL). We have already used interplanetary electric field data to predict ESF. The airglow systems we are installing worldwide detect the depletion zones that are so disruptive to communications and navigation systems and hence can be used to check the predictions of severe weather. Concerning GPS, we will first calibrate the COSMIC system using incoherent scatter radar, then apply it to (3) above. We are working with the TIGRIST team to field a geostationary imager.

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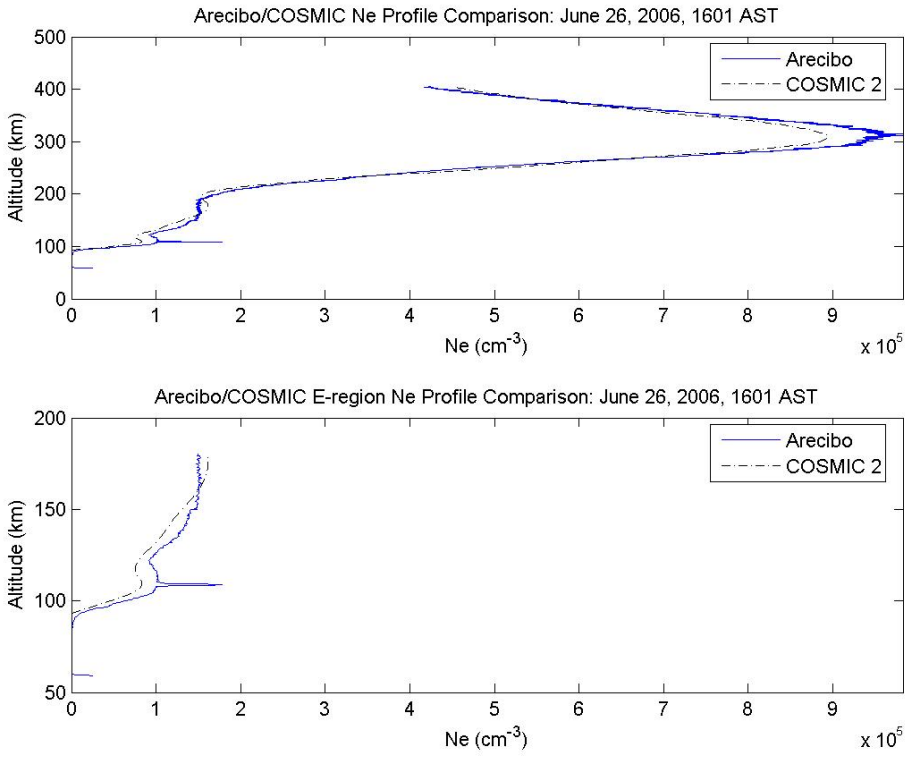

Figure 1. First calibration from the COSMIC GPS occultation experiment.

Figure 1 shows one calibration of the COSMIC GPS occultation experiment, which is quite good. We are exploring the reasons for the discrepancy in other examples. Many more passes will be examined and a paper will be submitted this year.

RESULTS

We have published a *Geophysical Research Letters* article entitled "On measuring the off-equatorial conductivity before and during convective ionospheric storms" [*Kelley et al*., 2004] under this grant and presented our calibration results twice at meetings in 2006. We hope to publish comparisons such as those above with as many as four models: IRI, AFRL, GAIM-JPL, and GAIM-USU.

IMPACT/APPLICATIONS

There is a great need for testing data assimilation methods in ionospheric space weather research. We will do this in one of the most important and severe space weather research areas. We feel that our testing methods will have an impact on the development of the AFRL assimilation model. The latter is a crucial component in a major DOD effort to predict communications and navigation outages in the C/NOFS Program. We also have some hope that by assimilating daytime TEC values and satellite electric field patterns we can predict ESF in the post-sunset period. GPS occultations are also to be used for assimilation models. Our calibration work is crucial in testing the validity of these data.

TRANSITIONS

We articulated an ESF prediction method, based on interplanetary data , that is capable of a 1-hour lead time and passed it on to the Air Force Research Laboratory.

RELATED PROJECTS

AFOSR funding of imagers in Hawaii for the C/NOFs project.

PUBLICATIONS

Kelley, M.C., V.K. Wong, G.A. Hajj, and A.J. Mannucci, On measuring the off-equatorial conductivity before and during convective ionospheric storms, *Geophys. Res. Lett*., *31*, L17805, doi:10.1029/2004GL020423, 2004. [published, refereed]

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Kelley, M.C., and J. Retterer, First successful prediction of a convective ionospheric storm using solar wind parameters, *Nature Geophys*., submitted, 2007.